Claims

1. An electrochemical cell comprising

an anode compartment,

an anode located in the anode compartment,

an anolyte comprising an aqueous acidic solution containing an organic contaminant,

a pump for circulating the anolyte through the anode compartment,

a cathode compartment,

a cathode located in the cathode compartment,

a catholyte ,

a pump for circulating the catholyte through the cathode compartment,

a separator between the anode and the cathode, comprising an ionically conducting solid polymer membrane material, and

a power supply for supplying dc current to the cell,

wherein the anode includes an active material which is stable at acid pH and at high electrical potential, and which selectively breaks down organic compounds by electrochemical oxidation, and wherein the separator preferentially allows the passage of protons over other ions.

2. An electrochemical cell according to Claim 1, wherein the anode active material is in the form of a solid material, or a coating of active material on a solid substrate.

3. An electrochemical cell according to Claim 2, wherein the solid material or solid substrate is a high surface area material.

4. An electrochemical cell according to Claim 3, wherein the solid substrate is a metal substrate.

5. An electrochemical cell according to Claim 4, wherein the active material coating comprises tin dioxide, lead dioxide or platinum based materials.

6. An electrochemical cell according to Claim 5, wherein the metal substrate is titanium.

7. An electrochemical cell according to Claim 1, wherein the cathode is of a material selected from the group consisting of stainless steel and titanium, which may include an oxide layer, glassy carbon and platinum based materials.

8. An electrochemical cell according to Claim 1, wherein the separator is a cation exchange membrane.

9. An electrochemical cell according to Claim 1, wherein the separator is a bipolar membrane.

10. An electrochemical cell according to Claim 1, wherein the separator is a perfluorinated cation membrane.

11. An electrochemical cell according to Claim 1, wherein the separator is a monovalent cation selective membrane selected from polystyrene monovalent and polysulfone monovalent membranes.

12. An electrochemical cell according to Claim 1, wherein the catholyte comprises an aqueous acidic solution.An electrochemical cell according to Claim 12, wherein the catholyte is of a lower ionic strength than the anolyte.

13. An electrochemical cell according to Claim 12, wherein the anolyte additionally comprises a metal ion, and wherein the cell additionally comprises a metal removal and return unit, for removing metal and/or metal ions from the catholyte.

14. An electrochemical cell according to Claim 13, wherein the metal ion is in a metal plating bath selected from copper, tin and zinc plating baths.

15. A process for electrochemically reducing the amount of an organic contaminant in an aqueous solution containing such contaminant, comprising

(a) providing an electrochemical cell, the electrochemical cell comprising

an anode compartment,

an anode located in the anode compartment,

an anolyte comprising an aqueous acidic liquid mixture containing an organic contaminant,

a first pump for circulating the anolyte through the anode compartment,

a cathode compartment,

a cathode located in the cathode compartment,

a catholyte ,

a second pump for circulating the catholyte through the cathode compartment,

a separator between the anode and the cathode, comprising an ionically conducting solid polymer membrane material, and

a power supply for supplying dc current to the cell,

wherein the anode includes an active material which is stable at acid pH and at high electrical potential, and which selectively breaks down organic compounds by electrochemical oxidation, and wherein the separator preferentially allows the passage of protons over other ions,

(b) activating the dc power supply to provide electrical current to the cell,

(c) activating the first pump to circulate the anolyte through the anode compartment to expose the liquid mixture to the anode to selectively break down the organic contaminant by electrochemical oxidation,

(d) activating the second pump to circulate the catholyte through the cathode compartment, and

(e) removing the aqueous solution having a reduced amount organic contaminant from the anode compartment.

16. A process according to Claim 15, wherein the anode current density is in the range of 1-200 mA/cm^2 .

17. A process according to Claim 16, wherein the anode current density is in the range of 10-75 mA/cm^2.

18. A process according to Claim 15, the catholyte comprises an aqueous acidic solution, and wherein the ionic strength of the catholyte solution is adjusted to provide a lower ionic strength than that of the anolyte.

19. A process according to Claim 18, wherein the aqueous solution includes a metal ion, selected from copper, zinc and tin.

20. A process according to Claim 19, additionally comprising removing the catholyte to remove metal and/or metal ions therefrom and returning the catholyte to the cell.

21. A process according to Claim 15, wherein the anode material is a stable substrate coated with an active layer of platinum based material.

22. A process according to Claim 15, wherein the anode material is a high surface area predominately platinum coated anode run at a low current density (i.e. below 10 mA/cm^2 and preferably below 2 mA/cm^2).

23. A process according to Claim 15, wherein the separator is a bipolar membrane, and wherein the current density through the membrane is kept below the threshold for metal precipitation.

24. A process according to Claim 15, wherein the separator is a cation membrane, and wherein the ionic strength is adjusted to balance the water flux through the membrane.

25. A process according to Claim 24, wherein metal deposits on the cathode are removed without cell disassembly by periodic anodic polarisation versus an additional electrode external to the electrochemical cell.

26. A process according to Claim 24, wherein the cathode is an oxide forming metal or glassy carbon to which metals deposits are poorly adherent.

27. A process according to Claim 24, wherein the poorly adherent metal deposits on the cathode are removed without cell disassembly by periodic application of ultrasound and collection of the metal particles from the catholyte flow.

28. A process according to Claim 24, wherein the poorly adherent metal deposits on the cathode are dislodged by masking areas of the cathode to produce local high current densities which result in loose, fluffy, poorly adherent metal deposits which can be detached by the catholyte flow and the high local rate of gas evolution.

29. A process according to Claim 24, wherein metal deposits on the cathode are removed without cell disassembly by periodic recirculating of a metal stripping solution such as diluted nitric acid or hydrogen peroxide.